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ABSTRACT

Reported is a study of the verbal behaviors used by biology students in inquiry and noninquiry settings. The population for this study included 10 BSCS teachers who had enrolled for two semesters in an instructional program designed to make teachers aware of alternative skills and strategies of inquiry; to recognize those used in their own classrooms; to select, practice, and implement selected strategies; and to plan instructional activities to develop inquiry behaviors in students. This Instructional Staff Development (ISD) Program was designed for experienced teachers interested in improving inquiry learning in their classrooms. Each participating teacher was videotaped in one randomly selected class before and after instruction in the ISD program. Verbalized behaviors were coded using the Revised Inquiry Analysis Instrument. The "Self-pairing" of observations technique was used with measurement of the same individuals before and after treatment. Results showed the percentage of total teacher talk was significantly lower in the inquiry setting and student talk higher. Variety of verbal influence behaviors used by students was greater. The percentage of time spent verbalizing "data analysis and interpretation" and "procedures" was significantly greater in the inquiry setting. (Author/EB)

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A STUDY OF STUDENT VERBAL BEHAVIORS IN INQUIRY AND NONINQUIRY SETTINGS IN BIOLOGY

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A STUDY OF STUDENT VERBAL BEHAVIORS IN INQUIRY AND NONINQUIRY SETTINGS IN BIOLOGY

Problem

It is the purpose of this paper to objectively identify verbal behaviors observed in inquiry settings and to compare these with the verbal behaviors observed in noninquiry settings. For purposes of this paper, inquiry has been defined as "a set of activities directed towards solving an open number of related problems in which the student has as his principal focus a productive enterprise leading to increased understanding and application."[1]

Population and Procedures

The University of Nebraska-Lincoln Teachers College in cooperation with the Mid-continent Regional Educational Laboratory, Inc., Kansas City, has conceptualized, developed and tested a staff development program designed for experienced teachers who are interested in improving inquiry learning in their classrooms. The program is designed to make teachers aware of alternative skills and strategies of inquiry; to recognize those used in their own classrooms; to select, practice, and implement selected strategies; and to plan instructional activities to develop inquiry behaviors in students.

The population for this study included ten BSCS teachers who had enrolled for two semesters in this Instructional Staff Development (ISD) Program in Inquiry for university credit. These biology teachers taught in the Omaha

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[1] Inquiry Objectives in the Teaching of Biology, Richard M. Bingman, Editor, Kansas City: Mid-continent Regional Educational Laboratory, Inc., September, 1969, p. 1.

and Lincoln, Nebraska, area schools. Two trainers who were also classroom biology teachers conducted the program after participating in a workshop designed to prepare trainers.

The instructional treatment included six components or units of study in fifteen instructional sessions and five microteaching sessions. Each participating teacher was videotaped in one randomly selected class before and after instruction in the ISD program. Verbalized behaviors were coded from the videotaped observations using the Revised Inquiry Analysis Instrument. Coders were consistent in the identification of categories of behavior at the 90 percent level.

Research Design

The "Self-pairing" of observations technique was used with measurement of the same individuals before and after treatment. This technique reduces extraneous influences on the variable being measured. That is, pairing reduces the effect of subject-to-subject variability.

To compute t for paired samples, the paired difference variable $D = X_1 - X_2$ is formed. D is normally distributed with mean δ. The sample mean and variance $\bar{d}$ and s_d^2 are computed, then:

$$t = \frac{\bar{d} - \delta}{s_{\bar{d}}} \quad ; \qquad df = n - 1 \text{ where n is the number of pairs, and}$$

$$s_{\bar{d}} = \sqrt{\left(s_1^2 + s_2^2 - \frac{2\, x_1 x_2}{n - 1} \right) / n}$$

$\frac{\sum x_{1_i}\, x_{2_i}}{n - 1}$ is the covariance between X_1 and X_2.

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[1] Statistical Package for the Social Sciences: Update Manual, Norman H. Nie, et. al., National Opinion Research Center, University of Chicago, Revised April 1972.

Description of the Instrument

The Revised Inquiry Analysis System[1] is an observational instrument designed to simultaneously record three kinds of verbal behavior in three respective columns: (See Figure 1.)

(a) Column One: Categories one through ten identify the verbal influence behaviors as defined by the ten categories of Flanders Interaction Analysis.

(b) Column Two: Categories one through seven identify the verbal influence behaviors used by students and defined as being analogous to the seven categories of teacher behavior as defined by Flanders Interaction Analysis.

(c) Column Three: Categories one through nine identify verbalized inquiry and noninquiry behaviors.

When this instrument was applied, a three-digit code was recorded every three seconds or with every behavior change, whichever occurred first. When the teacher was talking, the appropriate code was recorded in Column One, zero in Column Two (unless it was a decision), and the appropriate inquiry or noninquiry code in Column Three. For example, a teacher's factual question would be coded 401. If a student was speaking, an "8" or "9" was coded for Column One, the appropriate category was recorded for Columns Two and Three. For example, a student initiating a question about procedures would be recorded as 946. Silence or confusion was coded as 100.

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[1]This instrument was designed with input from the following: "The Inquiry Analysis System," Component III: Inquiry Behaviors, John E. Lux, et. al., July 1972, Copyright 1972 by Mid-continent Regional Educational Laboratory, Inc. pp. H308-1 to H308-4; "Cognitive Operations Monitored in the Classroom," Recording Teacher and Pupil Verbal Inquiry Behaviors in the Classroom, a technical manual for observers, John R. Anderson and Richard M. Bingman, October 1969, Copyright 1969 by McREL; and Inquiry Objectives in the Teaching of Biology, Richard M. Bingman, Editor, Copyright 1969 by McREL and the Biological Sciences Curriculum Study.

Figure 1

REVISED INQUIRY ANALYSIS SYSTEM INSTRUMENT

Column One (Interaction Analysis)	Column Two (Student Talk & Decisions)	Column Three (Inquiry Behaviors)
1 - Tchr. Accepts Feelings	1 - Student Accepts/States Feelings	1 - Factual Analysis
2 - Tchr. Reinforcement/Humor	2 - Student Reinforces/Humor	2 - Analysis, Interpretation, Identifying Relationships
3 - Tchr. Uses Student Ideas	3 - Student Uses Ideas of Others	3 - Hypotheses, Plans to Follow
4 - Tchr. Questions	4 - Student Questions	4 - Process (Inquiry into Inquiry)
5 - Tchr. Gives Information	5 - Student Gives Information	5 - Feelings, Attitudes, Values
6 - Tchr. Gives Directions	6 - Student Gives Directions	6 - Procedures
7 - Justification of Authority, Criticism by Tchr.	7 - Student Justifies Authority, Criticizes	7 - Sensory Observations
8 - Student Responses	8 - Decision based on Stated Alternatives	8 - Identification &/or Goal or Problem Formulation
9 - Student Initiated Talk		9 - Assessment of Content/Process
10 - Silence, Confusion	0 - Blank (Teacher Talk)	0 - Noninquiry

Hypotheses

It was hypothesized that after instruction in the ISD program:

1. Teachers would use more indirect (Column I, Categories 1 through 4) than direct (Column I, Categories 5 through 7) verbal influence behaviors.

2. Students would use a greater variety of verbal behaviors (Column II, Categories 8 and 9 compared to Categories 1 through 7).

3. Students would use a greater variety of verbal behaviors (Column II, Categories 1 through 7).

4. The mean percentage of time used for verbalizing decisions would increase (Column II, Category 8).

5. Students would increase their use of indirect verbal influence behaviors (Column II, Categories 1 through 4).

6. The total percentage of time verbalizing inquiry behaviors (excluding the category of "factual data") would increase (Column III, Categories 2 through 9).

Results

Results in terms of the mean percentages of time spent in the verbal behaviors identified in Columns I, II and III of the Revised Inquiry Analysis System are reported in this section.

Table I reports the mean percentages of time spent in behaviors identified by Column I categories. Data indicate that the teacher talk categories of "reinforcement/humor" (2), "use of student ideas" (3), "questions" (4), and "information-giving" (5) decreased at the .001 level of significance.

Category 7, "criticizes/justifies authority" also decreased at the .05 level of significance. The mean percentages of teacher categories of "accepting feelings" (1) and "direction-giving" (6) did not change significantly.

Table I

COMPARISON OF MEAN PERCENTAGES OF COLUMN I CATEGORIES OF VERBAL BEHAVIOR, PRE AND POST OBSERVATIONS

Category Descriptions	PRE $\bar{X}$	PRE S.D.	POST $\bar{X}$	POST S.D.	t Value	Significance Level
1. Teacher Accepts Feelings	11.58	13.95	17.41	4.63	1.24	N.S.
2. Teacher Reinforces, Humor	3.67	1.89	.10	.26	6.11	.001
3. Teacher Uses Student Ideas	5.38	3.08	.14	.27	5.16	.001
4. Teacher Questions	13.84	6.66	.64	.93	6.46	.001
5. Teacher Gives Information	42.07	21.51	2.61	4.17	5.22	.001
6. Teacher Gives Directions	3.72	2.77	2.80	2.97	.59	N.S.
7. Teacher Criticizes/ Justifies Authority	.64	.82	.01	.03	2.27	.05
8. Student Response	14.01	8.35	.17	.31	5.01	.001
9. Student Initiated Talk	4.69	4.96	75.87	9.83	19.18	.001

Category 8, "student response", decreased significantly at the .001 level while category 9, "student initiated talk", increased from a mean of 18.70 percent to a mean of 76.04 percent.

The mean percentage of indirect teacher behaviors was 34.47 percent before instruction and 18.29 percent after instruction. Direct teacher behaviors decreased from 46.43 percent to 5.42 percent.

Table II reports means, standard deviations and significance levels of changes for the categories of student verbal behaviors and of student and teacher decisions. All categories of student verbal behaviors increased after instruction. Category 2, "Student reinforcement/humor"; category 4, "student questions"; and category 5, "student gives information increased at the .001 level of significance. Category 6, "student gives directions" increased at the .01 level while category 7, "student criticizes/justifies authority" increased at the .05 level. Category 1, "student accepts/expresses feelings" and category 3, "student uses ideas of others" also increased from no occurrence before instruction to means of 4.89 percent and 2.00 percent respectively.

The mean percentage of student indirect verbal behaviors was 1.73 percent before instruction and 27.78 percent after instruction. Direct student behaviors decreased from 16.99 percent to 11.29 percent.

Mean percentage of time that decisions (Column II, Category 8) were verbalized, did not change significantly.

Table III reports the mean percentages of time spent in the specific inquiry behaviors identified in Column III categories. Total time using inquiry behaviors excluding "factual data" increased from a mean of 20.68 percent to 40.35 percent. The verbalization of "factual data", category 1, decreased significantly at the .05 level from a mean of 65.00 percent to a mean of 32.08 percent. Significant changes occurred in the behaviors of "analysis, interpretation, and identifying relationships", category 2, at the .10 level and in "procedures", category 6, at

Table II

COMPARISON OF MEAN PERCENTAGES OF COLUMN II CATEGORIES OF VERBAL BEHAVIOR, PRE AND POST OBSERVATIONS

Category Descriptions	PRE $\bar{X}$	PRE S.D.	POST $\bar{X}$	POST S.D.	t Value	Significance Level
1. Student Accepts/Expresses	.00	0	4.89	0		
2. Student Reinforces/Humor	.07	.20	10.83	5.64	5.72	.001
3. Student Uses Ideas of Others	.00	0	2.00			
4. Student Questions	1.66	1.60	10.06	3.15	8.15	.001
5. Student Gives Information	16.96	8.43	52.60	7.42	9.27	.001
6. Student Gives Directions	.01	.03	2.88	2.47	3.47	.01
7. Student Criticizes/	.02	.07	1.17	1.40	2.56	.05
8. Decisions	.37	.69	.44	.46	.28	N.S.

Table III

COMPARISON OF MEAN PERCENTAGES OF COLUMN III CATEGORIES OF VERBAL BEHAVIOR, PRE AND POST OBSERVATIONS

Category Descriptions	PRE $\bar{X}$	PRE S.D.	POST $\bar{X}$	POST S.D.	t Value	Significance Level
1. Factual Data	65.00	21.02	37.66	19.89	2.65	.05
2. Analysis, Interpretation, Identifying Relationships	8.70	4.99	24.28	5.66	2.02	.10
3. Hypotheses, Plans	2.01	3.92	.17	.40	1.38	N.S.
4. Process of Inquiry	.61	1.28	.01	.03	1.39	N.S.
5. Feelings/Attitudes/Values	.22	.63	.12	.21	.43	N.S.
6. Procedures	5.81	4.24	13.18	7.92	2.21	.05
7. Sensory Observations	1.60	2.89	.88	2.14	.54	N.S.
8. Identification of Goal/ Problem	.20	.53	.39	.55	.66	N.S.
9. Assessment	1.53	3.23	1.32	1.75	.17	N.S.

the .05 level. While other verbalized inquiry behavior categories did not change significantly, it should be noted that the proportion of student talk significantly increased (see Table I) indicating that use of inquiry behaviors by students increased while teacher use of the behaviors decreased.

Conclusions

1. Hypothesis one was accepted with indirect teacher behaviors decreasing from a mean of 34.47 percent to a mean of 18.29 percent after instruction while direct teacher behaviors decreased from a mean of 46.43 percent to a mean of 5.42 percent.

2. Hypothesis two was accepted with the total percentage of student talk increasing from a mean of 18.70 percent before instruction to a mean of 76.04 percent after instruction.

3. Hypothesis three was accepted with five student talk categories being used before instruction and seven student categories being used after instruction. All categories of student talk increased after instruction.

4. Hypothesis four was rejected since the percentage of time for verbalizing decisions did not change significantly.

5. Hypothesis five was accepted with student indirect behaviors increasing from a mean of 1.73 percent before instruction to a mean of 27.78 percent after instruction.

6. Hypothesis six was accepted with the mean percentage of all inquiry behaviors (excluding "factual data" increasing from 20.68 percent before instruction to 40.35 percent after instruction.